

## Open Channel (feet)

### Definition

Constructing or improving a channel, either natural or artificial, in which water flows with a free surface.

### Scope

This standard applies to construction of open channels or modifications of existing streams or ditches. Design criteria for channel stability and maintenance of flood water diversions (400), floodways (404), or surface drainage, main or lateral (608), having a drainage area in excess of 1 mi<sup>2</sup> (1.6 km<sup>2</sup>) shall be in accord with this standard for open channels. It does not apply to diversions (362), grassed waterways (412), irrigation field ditches (388), surface drainage, field ditches (607), or irrigation canals or laterals (320).

### Purpose

To provide discharge capacity required for flood prevention, drainage, other authorized water management purposes, or any combination of these purposes.

### Conditions where practice applies

This standard applies to all earth channel construction or modification except as noted under "Scope."

It also applies where stability requirements can be met, where the impact of the proposed construction on water quality, fish and wildlife habitat, forest resources, and quality of the landscape is evaluated and the techniques and measures necessary to overcome the undesirable effects are made part of any planned work, where an adequate outlet for the modified channel reach is available for discharge by gravity flow or pumping, and where excavation or other channel work does not cause significant erosion, flooding, or sedimentation.

### Planning considerations

#### Water Quantity

1. Effects on components of the water budget, especially on volumes and rates of runoff and infiltration.

#### Water Quality

1. Effects of erosion and the movement of sediment and soluble and sediment-attached substances in runoff during and immediately after construction.
2. Effects of the use of chemicals during vegetation control.
3. Effects of changes in channel vegetation on downstream water temperature.
4. Potential for temporary and long-term effects on the visual quality of downstream waters.

#### Design criteria

**Plan.** Channel construction or modification shall be according to an approved plan prepared for the site. ~~TR-25 shall be used in surveys, planning, and site investigations for channel work.~~ Design criteria in TR-25 shall be followed, using the procedure best adapted to site conditions.

In selecting the location and design of channels, careful consideration shall be given to minimizing water pollution, damage to fish and wildlife habitat, and to protecting forest resources and the quality of the landscape. In considering requirements for construction and operation and maintenance, selected woody plants must be preserved. The overall landscape character, prominent views, and fish and wildlife habitat requirements must be considered.

Planned measures necessary to mitigate unavoidable losses to fish or wildlife habitat shall be included in the project. The quality of the landscape shall be maintained by both the location of channel works and plantings, as appropriate.

The alignment of channels undergoing modifications shall not be changed to the extent that the stability of the channel or laterals thereto is endangered.

**Capacity.** The capacity for open channels shall be determined according to procedures applicable to the purposes to be served and according to related engineering standards and guidelines in handbooks. The water surface profile or hydraulic gradeline for design flow shall be determined according to guidelines for hydraulic design in TR-25. The  $n$  value for aged channels shall be based on the expected vegetation, along with other retardance factors, considering the level of maintenance prescribed in the operation and maintenance plan prepared with the owners or sponsors. The required capacity may be established by considering volume-duration removal rates, peak flow, or a combination of the two, as determined by the topography, purpose of the channel, desired level of protection, and economic feasibility.

**Cross section.** The required channel cross section and grade shall be determined by the plan objectives, the design capacity, the materials in which the channel is to be constructed, the vegetative establishment program, and the requirements for operation and maintenance. A minimum depth may be required to provide adequate outlets for subsurface drains, tributary ditches, or streams. Urban and other high-value developments through which the channel is to be constructed must be considered in the design of the channel section.

**Channel stability.** Characteristics of a stable channel are:

1. The channel neither aggrades nor degrades beyond tolerable limits.
2. The channel banks do not erode to the extent that the channel cross section is changed appreciably.
3. Excessive sediment bars do not develop.
4. Gullies do not form or enlarge because of the entry of uncontrolled surface flow to the channel.

All channel construction and modification (including clearing and snagging) shall be according to a design that can be expected to result in a stable channel that can be maintained at reasonable cost. Vegetation, riprap, revetments, linings, structures, or other measures shall be used if necessary to insure stability.

The method applicable to site channel in TR-25 shall be used in determining the stability of proposed channel improvements.

Bankfull flow is the flow in a channel that creates a water surface at or near the normal ground elevation, or the tops of dikes or continuous spoil banks that confine the flow for a significant length of a channel reach.

Channels must be stable under conditions existing immediately after construction (as-built condition) and under conditions existing during effective designed life (aged condition). Channel stability shall be determined for discharges under these conditions as follows:

1. As-built condition - Bankfull flow, design discharge, or 10-year frequency flow, whichever is smallest, but not less than 50 percent of design discharge.

The allowable as-built velocity (regardless of type of stability analysis) in the newly constructed channel may be increased by a maximum of 20 percent if:

- a) The soil and site in which the channel is to be constructed are suitable for rapid establishment and support of erosion-controlling vegetation.
- b) Species of erosion-controlling vegetation adapted to the area and proven methods of establishment are known, and
- c) The channel design includes detailed plans for establishing vegetation on the channel side slopes.

2. Aged condition - Bankfull flow or design discharge, whichever is larger, except that it is not necessary to check stability for discharge greater than the 100-year frequency. Stability checks that are flow related are not required if the velocity is 2 ft/s (0.6 m/s) or less.

For newly constructed channels in fine-grained soils and sands, the  $n$  values shall be determined according to procedures in chapter 6 of TR-25, and shall not exceed 0.025. The  $n$  value for channels to be modified by clearing and snagging only shall be determined by reaches according to the expected channel condition upon completion of the work.

**Appurtenant structures.** The channel design shall include all structures required for proper functioning of the channel and its laterals, as well as travelways for operations and maintenance. Inlets and structures needed for entry of surface and subsurface flow into channels without significant erosion or degradation shall be included in the channel design. The design also shall provide for necessary flood gates, water-level-control devices, bays used in connection with pumping plants, and any other appurtenances essential to the functioning of channels and contributing to attainment of the purposes for which they are built. If needed, protective structures or treatment shall be used at junctions between channels to insure stability at these critical locations.

The effect of channel work on existing culverts, bridges, buried cables, pipelines, irrigation flumes, and inlet structures for surface and subsurface drainage on the channel and laterals thereto shall be evaluated to determine the need for modification or replacement.

Culverts and bridges that are modified or added as part of channel projects shall meet reasonable standards for the type of structure and shall have a minimum capacity equal to the design discharge of state agency design requirements, whichever is greater. Capacity of some culverts and bridges may need to be increased above the design discharge.

**Disposition of spoil.** Spoil material from clearing, grubbing, and channel excavation shall be disposed of in a manner that will:

1. Not confine or direct flows so as to cause instability when the discharge is greater than the bankfull flow.
2. Provide for the free flow of water between the channel and flood plain unless the valley routing and water surface profile are based on continuous dikes being installed.
3. Not hinder the development of travelways for maintenance.
4. Leave the right-of-way in the best condition feasible, consistent with the project purposes and adjacent land uses.
5. Direct water accumulating on or behind spoil areas to protected outlets.

6. Maintain or improve the visual quality of the site to the extent feasible.

**Vegetation of channel.** Vegetation shall be established on all channel slopes, berms, spoil, and other disturbed areas according to the SCS standard for channel vegetation (322).

### **Operation and maintenance**

**Plan.** An operation and maintenance plan must be prepared for each channel system. Minimum requirements for operation, maintenance, and replacement shall be consistent with the design objectives. This includes consideration of fish and wildlife habitat, quality of the landscape, water quality, mitigation features, methods, equipment, costs, stability, function for design life, frequency, and time of year for accomplishing the work. Detailed provisions for operation and maintenance must be made if complex features, such as water-level-control structures and pumping plants, are required.

**Maintenance access.** Travelways for maintenance generally shall be provided as part of all channel work. This requirement may be met by providing reading access points to sections of the channel if this will permit adequate maintenance in conformance with the operation and maintenance plan.

A travelway shall be provided on each side of large channels if necessary for use of maintenance equipment. Travelways must be adequate for movement and operation of equipment required for maintenance of the channel. The travelway may be located adjacent to the channel on a berm or on the spread spoil. In some places the channel itself may be used as the travelway. The travelway, including access points, must blend into the topography, the landscape, and adjacent land uses.

**Safety.** Open channels can create a safety hazard. Appropriate safety features and devices should be installed to protect people and animals from accidents such as falling or drowning.

### **Plans and specifications**

Plans and specifications for constructing open channels shall be in keeping with this standard and shall describe the requirements for properly installing the practice to achieve its intended purpose.

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#### Design Criteria

##### Channel Stability

In the humid sections of the United States and at other locations where vegetation can be rapidly established by natural or artificial means, the allowable as-built velocity (regardless of type stability analysis) in the newly constructed channel may be increased by a maximum of 20 percent. The 20 percent adjustment does not apply to the allowable velocity for aged condition. This increase is justified only if:

1. The soil and site in which the channel is to be constructed are suitable for rapid establishment and support of erosion-controlling vegetation.
2. Species of erosion-controlling vegetation adapted to the area and proven methods of establishment are known, and
3. The channel design includes detailed plans for establishing vegetation on the channel side slopes.

For newly constructed channels in fine-grained soils and sands, the "n" values shall be determined according to specifications in chapter 6 of TR-25, and shall not exceed 0.025. The "n" value for channels to be modified by clearing and snagging only shall be determined by reaches according to the expected channel condition upon completion of the work.

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**OPEN CHANNEL SPECIFICATIONS**

**Excavation**

The channel shall be cut to the line and grade shown on the plans or as staked in the field.

**Spoil Placement**

Spoil shall be spread and leveled so that the surface water can flow into the ditch. If the spoil is to be farmed, it shall be spread so that farming operations will not be hindered. All spoil that is not to be farmed shall be vegetated in accordance with the SCS standard for channel vegetation (322).

**Maintenance**

Provisions shall be made for maintaining the channels and their outlets to permit effective drainage.

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OPEN CHANNEL ENGINEERING NOTEKEEPING

Design Survey, Design and Plans

- A. The following information should be obtained and recorded.
1. Location map (may be by reference to conservation plan).
  2. Drainage area.
  3. Profile drawing where needed for design or construction.
  4. Typical cross sections showing bottom width, depth, side slopes, and plans for spoil disposal.
  5. Outlet conditions or outlet structures.
  6. Earthwork quantity computations - where applicable on approved forms or in engineering field book.
- B. Cross reference to appropriate engineering field books will be made on drawings and plans.

Construction Check

- A. The following information shall be recorded as supporting data when the job is completed.
1. At least one cross section of each channel checked and others as necessary to determine if constructed side slopes, depth, bottom width, spoil placement and berm widths meet specifications.
  2. Grades of the completed channel where grades are designed.
  3. Length of all channels installed.
  4. Revised earthwork quantity computations, if changes were made during construction and if needed for performance certification.
  5. Data on structures if appropriate.
  6. Adequacy of outlet.

7. Certification that practice meets standards and specifications. Note any exceptions.
8. Date and signature of person making the construction check.

### **Recording Data**

Field survey and construction check data will be recorded in a standard engineering field book or on other appropriate forms in accordance with Technical Release No. 62. For items not covered herein, follow standard survey and notekeeping procedures contained in Technical Release No. 62 and Chapter 1, Engineering Field Manual for Conservation Practices.